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Length Matters – The Einstein–Swann Correspondence and the Constructive Approach to Special Relativity

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Considerable attention has been drawn lately to the distinction, attributed to Einstein, between principle theories and constructive theories, and to the methodological importance it may have to the scientific practice. Viewed as part of the context of discovery, however, this distinction is rarely acknowledged as having any philosophical importance, with the exception of Howard (2004) who urges us to regard it as one of Einstein's most valuable contributions to 20th-century philosophy of science. In this paper I would like to demonstrate this philosophical significance, suggesting that while the principle–constructive distinction furnishes the physicist with an important methodological tool, it also carries a philosophical weight, to the extent that it serves as a demarcation mark in what seems to be purely metaphysical debates.

Admittedly, while Einstein was not the first to introduce the distinction between principle theories and constructive theories to theoretical physics (e.g., Maxwell 1875, Poincaré 1905), he definitely popularized it when reflecting along his career on the conception of STR. Expressing the novelty of the theory, Einstein ultimately chose the principle view over the constructive view, but his misgivings about this choice (and about what he regarded as its unfortunate implications on the foundations of quantum mechanics) are well documented (Schilpp 1949, Janssen 2000, Brown 2005). What is also well documented is the attempt, made by his contemporaries Lorentz and FitzGerald, to think about the kinematical phenomena of electromagnetism in constructive dynamical terms (see, e.g., Janssen 1995). Other physicists who expressed, along with Einstein himself, dissenting constructive views of STR are less known in this context. They include Weyl, Pauli, and Eddington in the 1920s, W.F.G. Swann in the 1930s and the 1940s, and L. Janossy, and J.S. Bell in the 1970s. In a recent monograph entitled *Physical Relativity*, Harvey Brown (2006) adds himself to this distinguished list of unconventional views on STR. His aim is to advocate what he calls "The Big principle" of the constructive view: that the universal constraint on the dynamical laws that govern the nature of non-gravitational interactions, namely, their Lorentz-covariance, is the true lesson of STR. On this view, the explanatory arrow in STR between the structure of spacetime and the behavior of rods and clocks is reversed: if one could achieve a dynamical underpinning of this behavior with an ultimate Lorentz-covariant theory of matter, the "mystery of mysteries", i.e., how material bodies such as rods and clocks supposed to know which spacetime they are immersed in, will be dispelled, and Minkowski spacetime will retain its appropriate status as a "glorious non-entity" (Brown and Pooley 2004).

Brown's controversial view has stirred a lot of discussions in the philosophy of physics community. One of the open questions seems to be the following: what are the metaphysical commitments behind the constructive approach? More generally, how should one classify the constructive view to STR in terms of the classic debate between relationalism and substantivalism? For a conversant in the philosophy of spacetime literature the question may seem odd. After all, that this debate cannot be decided by the current available inventory of spacetime theories is one of the lessons of few seminal philosophical works in the field (Sklar 1977, Earman 1989). But note that in this case, instead of trying to extract metaphysics from a comparison across different physical theories, we are focusing on different approaches to the same physical theory. In other words, by classifying the constructive approach to STR in metaphysical terms, we are not trying to draw metaphysical lessons from the theory itself, but rather we regard the very process of theorizing as revealing the theoretician's latent metaphysics.

Such an inquiry resonates well with the broader intuition I would like to defend here, namely, that Einstein's distinction deserves much bigger a role than a mere methodological watershed in the practice of theoretical physics, and actually carries an important philosophical weight as a great divide in the philosophy of science. A strong argument in support of this intuition would amount to demonstrating that the constructive approach entails a unique metaphysical view and cannot be consistent with both sides of the classic debate in the philosophy of spacetime. Notably, disagreement with respect to this issue exists even among various proponents of this approach themselves (Pooley 2006). Thus, by exposing the unique metaphysical view that arises from the constructive approach I hope to achieve the modest goal of settling an open question in contemporary philosophy of physics. But the dividends of this inquiry are considerably higher: if successful, my result shall exemplify a new kind of historically-sensitive philosophy of science, wherein rather from scientific theories, philosophical lessons are drawn from the actual practice of science.

In order to achieve this goal I shall analyze the metaphysical classification of the constructive view to STR in light of arguments put forward by various theoretical physicists. In particular I shall take my cue from a rarely cited correspondence between Einstein and W.F.G. Swann, mentioned only briefly in Stachel (2002) and in Brown (2006). In this correspondence Swann presents Einstein with his constructive approach to STR, wherein rods and clocks are not introduced as primitive building blocks, or as "independent objects", but are taken instead to be material bodies obeying the Lorentz-covariant laws of the quantum theory of matter.

Einstein, in response, argues cryptically that any such constructive formulation of STR must, like the quantum theory, contain a fundamental scale of length. My key point will be to demonstrate how the postulation of a fundamental scale of length (which, according to Einstein, is a necessary consequence of the constructive approach) bears on one's metaphysical position in the philosophy of spacetime. To this end I shall offer several interpretations to Einstein's cryptic remark, couching them in historical context. The analysis clarifies further the role of general covariance in the classic debate between relationalism and substantivalism.